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MODEL AND SIMULATION TO MINIMIZE EMPTY SPACE LEFT WITH LAFF METHOD IN THE LOADING OF CARGO SYSTEM

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ABSTRACT

Logistics is to put resources at the right time, right place, at the right cost and right quality, therefore the iinformation technology is the important part of the logistic company. This explains why loading of cargo in container are given high priority among operational computer applications in the logistic company. Investigates the importance of information technology and its role in improving the loading of cargo systems in container. In this study, a computer simulation model is developed to do the simulation before load into the container to make sure the optimization process will look for the good arrangement pattern based on fitness or the best grade, that is the fewer empty space left. The objective in this study is how to make a good arrangement pattern in the two-dimension space in the container, which should be made as optimal as possible to minimized empty space by using Largest Area Fit-First(LAFF) method and its validity is examined through an illustrative example problem provided by a domestic courier service company in Indonesia.

KEYWORDS: Largest Area Fit-First(LAFF), Computer Simulation, Container & Minimize Empty Space

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Original Article

1. INTRODUCTION

Logistics is the science that needs to be studied further in considering the history of the increasingly complex economic growth such as the productivity of the resulting packages of various commodities factory or company increasingly varied, how the shipping and storages well as the management of the results of the overall products require special handling and are serious. Other definition of logistics is putting the resources at the right time, right place, right time, cost and quality.

An automated application is required to perform faster simulations to make time for a previous efficiency. Therefore, this study purpose is developing the system which can simulate the empty space in the container in order to efficiently empty space and minimize the occurrence of errors during manual placement of goods. A crucial element in the loading of goods in containers is the type of goods as well as the size of the goods and the container itself with the aim of filling the empty space inside the container to the maximum with the conditions set. If the contents of the container have a lot of empty space, then there are items left behind and cannot be put into a container so that the calculation or planning that has been determined to be missed and caused to book return containers that should not be needed.

The container shipping cost can be describing with the amount and the size of the packages that will be load in and how many the container that needed. A wide range of items with a certain kind of put into the box to avoid the occurrence of stuff strewn about during delivery. The boxes are arranged to make container full. The

logistic company usually has served many clients and within a day the average can serve up to 10 clients simultaneously. With the abundance of the planner client requires an automated application to perform simulations more quickly because the previous time for efficiency should make the draft images one by one and take that much. For that need to be made a simulation which can describe the packages of various commodities that can be included in order to look for an empty space in the container. LAFF is introduces to solve this problem by minimizing an empty space with put large items first in advance in accordance with the specifications have been entered and will continue to the size of small box in one container.

The remainder of the paper is as follows. The previous studies related to the problem considered are introduced in Section 2. Section 3 describes definition of the problem and the solution procedure. In Section 4. a numerical example is performed with the solutions. Finally, the conclusions and further research areas appear in Section 5.

2. LITERATURE REVIEW

Optimization arrangement of cylinders in the container by genetic algorithm [1]. This research has an important element in the loading of the packages of various commodities inside is a type of goods as well as a measure of the goods and the container itself with the provisions that have been set. If the contents of the container have a lot of empty space, then there are items that are left behind and could not be inserted into the container so that the calculation/planning set into a fumble and caused for booking return container that should not be necessary. From this research, the optimization of cylinder items to fit into the container was described. The optimization pattern of arrangement of packages in three dimensional space using genetic algorithm [2]. This study shows that the search space but does not have a limit problem and not placed into containers but can determine its own spacious room that will be tested. It can trigger a variety of results that much because it has no broad restriction and the item. An efficient algorithm for 3d rectangular box packing [3]. Based on these studies researchers learned that to do minimize empty space by specifying a large item in advance to be included on the first position and then continues up to the size of the smallest. This algorithm is called the method of Largest Area Fit-First (LAFF). In this study, a good arrangement pattern in the two-dimension space in the container will be developed by considering minimize the empty space to contain items without leaving a lot of empty space by using Largest Area Fit-First (LAFF) method.

3. PROBLEM STATEMENT AND ALGORITHM DEVELOPMENT

In this research, there aretwo main problem definitions:

- Knowing to do minimize empty space on one container
- Knowing to determine the layout of the placement of the items to be load in a container

In this section will define the inputs and outputs for the algorithm with the assumptions and then describe the proposed algorithm. The algorithm is based on the LAFF to solve the problems: (i) How to minimize empty space by perform the simulations using algorithms LAFF and place items with a certain size according to the maximum size of the container to fill the entire space of the container. (ii) How to determine the goods by entering the large size of goods prior to the item with the smallest size in one container.

Inputs and Output for Laff Algorithm

There are two kinds of variables which needed in this research:

- **Independent (Dimension Goods)**

Independent variables used in this study is the dimension of goods that are flexible with sizes that can be inserted according to the user wishes.

- **Dependent (Wide Containers)**

The dependent variable used in this research is the area inside the container because the wide will not change because the vast container is static and predetermined dimension that is equal to 20 feet.

The first input is the number of different sized boxes which depends on the input from the user. A measure that will be structured depending on the wishes of the user but the packaging shapes must be in box or cube and the size of the packaging only in centimeters. The size of the box and the container into the system using a comparative scale one centimeter = fifty pixels and not use a decimal number. In the execution of LAFF algorithm, the program produces output based on these conditions:The size of the container used is a 20feet container size (length: 605,800 cm; width: 243,800 cm; height: 259,100 cm). The output of this two-dimension simulation is based on the LAFF algorithm to know how many boxes can be loaded in one container until there are no boxes or no boxes can fit into the container spaces again.

How the Laff Algorithm Works

Based on the objective of this research, the simulation system is needed to solve the problem tominimize the empty space. The two dimensions' simulation is based on the LAFF method which the process of minimize empty space with arrange the largest boxes with the minimum height size, then continues with the remaining boxes to be placed in the container. This algorithm method is used to develop a simulation model which can counts how many items can fit into the container but not to simulate any incoming goods to minimize the empty space in the container. The optimum results for the solution of the problem can be found by trying all combinations of possible different solutions by developing the simulation in optimization to minimize the empty space in the container with the LAFF method. By using this method, we can determine the diameter of the goods in the form of boxes and container's wide that we can specify its own.

In order to perform the input of the diameter of boxes and containers such methods can determine the items that have a diameter of most can be included the first time and will be looking for an empty space corresponding to the size of the goods until the smallest loaded so that it is in line with the objective of this research to minimize the empty space. To determine the detail of the process of simulation, there are some important things that need to be declared such as: the placement of goods in containers empty spaces, required extensive display and calculation of container and extensive goods so as to produce a simulation in accordance with the user input. Finally, to check the optimization results by simulated 2D graphics with waste space variable entered with all empty space can be filled with packing in cube or box shapes. Figure 1 shows the class diagram of the simulation based on the LAFF method.

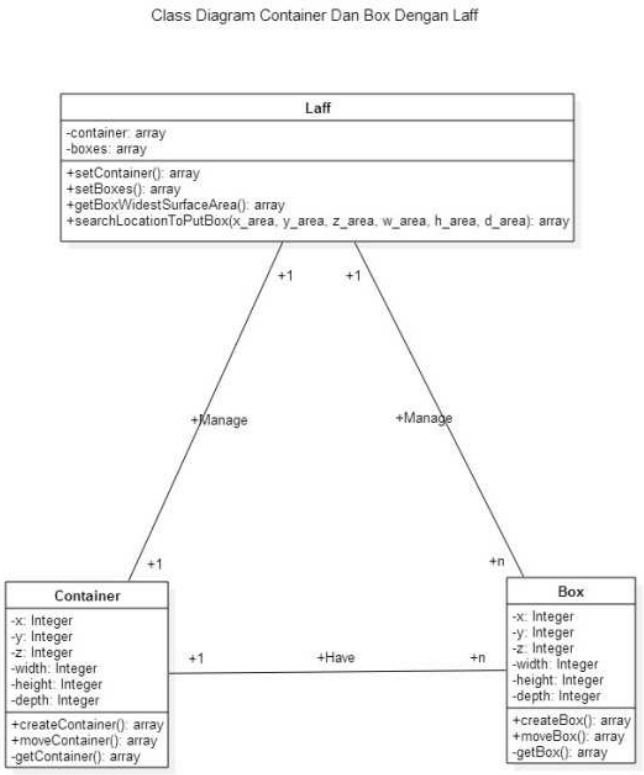

Figure 1: Class Diagram

In the simulation requires calculation of length, width and height of the box and the container size to fill empty space on the outer side of the container first and then fill the bottom side of the side can be doing continuously. The process will continue until there are no boxes or no boxes can fit into those spaces. In this step, if there is no space around the placed box, then the algorithm continues with the boxes with the largest surface area are determined and the selected boxes are searched to find a box that has minimum height out of all selected boxes. Then, the box with minimum height is placed in the container. All the process can be described in this below pseudocodes:

BOX_CHECK←Boxes[X]

PBC←DEPTH_BOX_CHECK

LBC←WIDTH_BOX_CHECK

TBC←HEIGHT_BOX_CHECK

PC←DEPTH_CONTAINER

LC←WIDTH_CONTAINER

TC←HEIGHT_CONTAINER

IF PC <=PBC AND <=LBC AND TC<=TBC THEN

IF BOX_PILIHAN<>NULL THEN

LUAS_BOX_CHECK←PBC * LBC

LUAS_BOX_CHOOSE←DEPTH_BOX_CHOOSE * WIDTH_BOX_PILIHAN

IF VOLUME_BOX_CHECK > VOLUME_BOX_CHOOSE THEN

BOX_CHOOSE=BOX_CHECK

ELSE

IF VOLUME_BOX_CHECK=VOLUME_BOX_CHOOSETHEN

IF TBC<HEIGHT_BOX_CHOOSE THEN

BOX_CHOOSE=BOX_CHECK

ENDIF

END IF

ENDIF

ELSE

BOX_CHOOSE=Boxes[X]

ENDIF

X←X+1

ENDWHILE

IMPLEMENTATION AND TESTING

Based on the all requirements that neededto develop the system, then the next step is to design the user interface of the containers and boxes that will be added in the system. In this stage, the user can add the size of the container and the size of the box by using a comparison scale varies due to the size of a laptop that is not too big that it cannot display the size of the original. The next stage is to make simulation placement of goods. In this stage, after the user adds the size of the container and then when the box is clicked Calculate button on the web will show images of containers with goods which have been prepared by the algorithm LAFF.

Figures 2 is a screenshot of the final appearance for the application on the website that will display the output of the simulation display images that have adjusted the size of the container and the size of the packages. The size of the packages can be input manually based on the real size while the size of container is fixed (20 feet).

Figure 2: Design Interface

If the users input the dimension (width, height and depth) box container, box item and click add box, it will show list of box item. After click add box, users have to click calculate to show simulation like in Figures 3.

In doing this calculation and simulation box diameter must be no larger than the diameter of the container. If there is a larger size compared between the packages and containers, then there will be packages that cannot be incorporated into the simulation which will be given information on the remaining box.

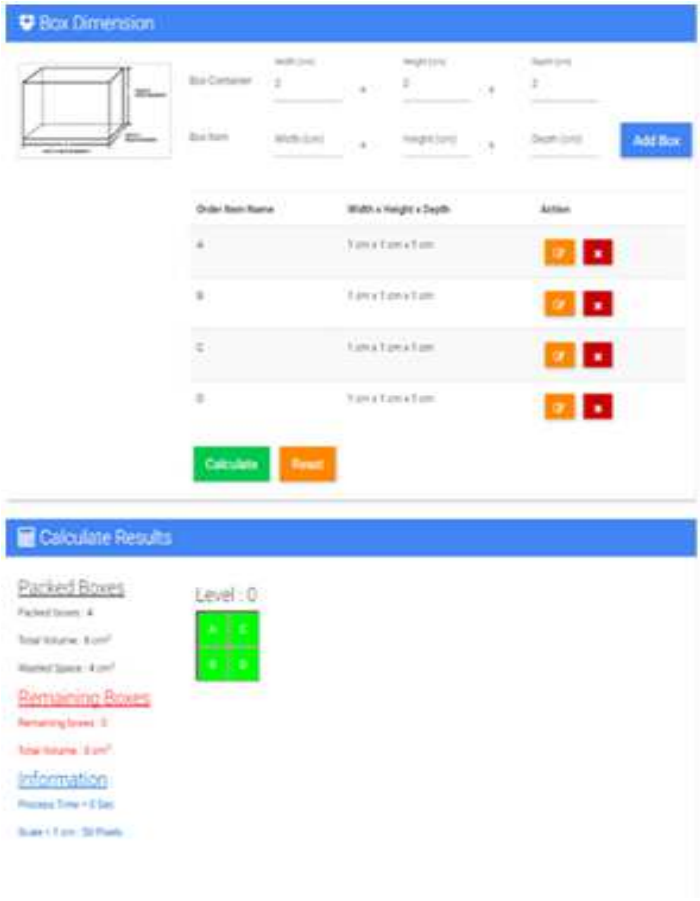

Figure 3: The Results

Testing of the program with several number of boxes with different size in order to see practical performance of the algorithm were done as many as 100 times. The program generates random boxes with different sizes as an input and then places the boxes into the container. Table 1 shows the few results of experiments.

Table 1: Results of Testing the Program

No	Total Box	Total Volume Box	Waste (%)	Time	Volume
1	9	62	1.59	0.1	1
2	6	54	14.29	0.1	9
3	8	63	0	0.1	0
4	3	13	79.37	0.1	50
5	4	40	36.51	0.1	23
6	7	58	7.94	0.1	5
7	5	42	33.33	0.1	21
8	9	58	7.94	0.1	5
9	5	63	0	0.1	0
10	5	53	15.87	0.1	10
11	4	52	17.46	0.1	11
12	6	62	1.59	0.1	1
13	5	34	46.03	0.1	29
14	6	53	15.87	0.1	10
15	4	56	11.11	0.1	7
16	7	51	19.05	0.1	12
17	6	66	-4.76	0.1	-3
18	10	70	-11.11	0.1	-7
19	4	46	26.98	0.1	17
20	4	60	4.76	0.1	3

Based on the result, the calculation of the remaining empty space with the calculation (container volume-the number of the volume of the box)/volume container*100. The average waste is 22.3% while 77.7 is already fully loaded in the container. With this simulation, planner can simulate the packages of various commodities in accordance with the specified size and containers which have been determined. Also all the process will do it automatically with a view that has been made and to minimize errors due to computer simulation result in more detail than manual.

CONCLUSIONS

The result of this research is computer simulation to make sure the optimization process will look for the good arrangement pattern based on fitness or the best grade, that is the fewer empty space left. The good arrangement pattern in the two-dimension space in the container, which should be made as optimal as possible to minimized empty space by using Largest Area Fit-First (LAFF) methodto give the solution towards how the good arrangement pattern is optimized through the simulation. The simulation is expected to help the logistic companies with make sure in the arrangement fewer empty space left. Furthermore, other problems in logistic company can be solved and finding a better solution procedure for container problem will be studied in future research.

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